CLAIMS

1. A magnetic transduction sensor device, of the type comprising at least one magnetic layer (22; 32; 42; 122) configured to determine a variable magnetisation (MF) in response to the variation of a physical quantity (P, T), characterised in that said device (20; 30; 40; 50; 120) comprises a plurality of layers (11, 12, 13, 14, 15, 16, 17) arranged in a stack, said magnetic layer (22; 32; 42; 122) configured to determine a variable magnetisation (MF), in response to the variation of a physical quantity (P, T) interacting magnetically through said variable magnetisation (MF) with a free magnetic layer (11), able to be associated with a temporary magnetisation (MT), said free magnetic layer (11) belonging to said plurality of layers (11, 12, 13, 14, 15, 16, 17), which further comprises at least one spacer layer (13) and a permanent magnetic layer (12) associated to a permanent magnetisation (MP).

2. Sensor device as claimed in claim 1, characterised in that said physical quantity (P, T) is a pressure (P) and in that said sensor device (30; 30; 40; 50) further comprises a compressible layer (21; 31; 42) and in that said magnetic layer (22; 32; 42; 122) configured to determine a variable magnetisation (M) in response to the variation of a physical quantity (P, T) comprises a layer with high magnetic coercivity (22; 32; 42), said compressible layer (21; 31; 42) and layer with high magnetic coercivity (22; 32; 42) being associated with said plurality of layer (11, 12, 13, 14, 15, 16, 17).

3. Device as claimed in claim 2, characterised in that said compressible layer (21; 31; 42) is laid onto the free magnetic layer (11) and said layer with high magnetic coercivity (22; 32; 42) is laid onto said

compressible layer (21).

4. Device as claimed in claim 3, characterised in that said compressible layer (21; 31; 42) has such an uncompressed thickness (D) as to prevent the layer with high magnetic coercivity (22) from switching the temporary magnetisation (MT) associated with said free magnetic layer (11).

5. Device as claimed in claim 4, characterised in that said layer with high magnetic coercivity (32; 42) is obtained by means of a composite structure (34) comprising magnetic particles (33) contained in a resilient matrix (35).

6. Device as claimed in claim 5, characterised in that said plurality of layers (11, 12, 13, 14, 15, 16, 17) comprises a substrate (14), in turn comprising a recess (36) into which said sensor device (40, 50) is laid.

7. Device as claimed in claim 5 or 6, characterised in that said layer with high coercivity (32) contains the compressible layer (31) which is in the form of gel or foam or liquid.

8. Device as claimed in claim 5, characterised in that said layer with high magnetic coercivity (32; 42) comprising magnetic particles (33) contained in a resilient matrix is able to perform also the function of compressible layer (42).

9. Device as claimed in claims 2 through 8, characterised in that the compressible layer (21; 32; 42) is obtained by means of a porous composite material.

10. Device as claimed in one or more of the previous claims, characterised in that said plurality of layers (11, 12, 13, 14, 15, 16, 17) arranged in a stack configures a spin valve magnetic device (10).

11. Device as claimed in claims 1 through 10,

characterised in that it is associated to a pressure monitoring and/or restoring system of a tyre (52) positioned on a wheel (50), said system comprising a control unit (56) and one or more actuators (52) for blowing air into the tyre (52).

12. Manufacturing process of a pressure sensor device as claimed in claims 1 through 9, characterised in that it provides for depositing said compressible layer (21; 31) by means of a spinning process and/or by means of a casting process and/or by evaporation.

13. Manufacturing process as claimed in claim 12, characterised in that it provides for depositing said magnetic layer with high coercivity (22; 32; 42) by means of evaporation and/or electroplating techniques with electrochemical cell.

14. Sensor device as claimed in claim 1, characterised in that said physical quantity (P, T) is a temperature (T).

15. Device as claimed in claim 14, characterised in that said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the variation in temperature (T) is laid over the free magnetic layer (11).

16. Device as claimed in claim 15, characterised in that said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the variation in temperature (T) is a layer with low Curie temperature (T_c).

17. Device as claimed in claim 16, characterised in that it comprises a permanent magnetic layer with low saturation (124) deposited over said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the variation in temperature (T).

18. Device as claimed in claim 17, characterised in that it comprises a second spacer layer (21) to

separate the free magnetic layer (11) from said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the temperature variation (T).

19. Device as claimed in claim 16 or 17, characterised in that it comprises a third spacer layer (23) to separate said permanent magnetic layer with low saturation (124) from said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the temperature variation (T).

20. Device as claimed in at least one of the previous claims 14 through 19, characterised in that said permanent magnetic layer with low saturation (124) and/or said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the temperature variation (T) are obtained by means of a composite structure (34) comprising magnetic particles contained in a matrix.

21. Device as claimed in one or more of the previous claims 14 through 20, characterised in that said plurality of layers (11, 12, 13, 14, 15, 16, 17) arranged in a stack configures a spin valve magnetic device (10).

22. A process for manufacturing a temperature sensor device as claimed in claims 14 through 21, characterised in that it provides for depositing a permanent magnetic layer with low saturation (124) and/or said magnetic layer (122) configured to determine a variable magnetisation (MF) in response to the temperature variation (T) through a thin film plating process, in particular a process of thermal evaporation and/or electro-plating in Galvanic cell and/or casting and/or spinning.

23. Process as claimed in claim 22, characterised in that said thin film plating process comprises,

relatively to said magnetic layer (22) able to vary a magnetisation associated therewith in response to a temperature (T) the plating of a composite structure of magnetic particles in a matrix and to adjust the composition of said composite structure as a function of the Curie temperature (T_c) to be obtained.

24. Detection process of a physical quantity by magnetic transduction, employing the device as claimed in at least one of the claims 1 through 10 or 14 through 21.

25. Detection process as claimed in claim 24 when dependent on at least one of the claims from 1 through 10, characterised in that said physical quantity is a pressure (P) and in that the method comprises the following operations:

- realising said compressible layer (21; 31) with an uncompressed thickness (D) exceeding a threshold thickness (D_{th}) below which the layer with high coercivity (22; 32; 42) influences the magnetisation (MT) of the free magnetic layer (11);

- forcing an electrical current (I) in said sensor device (20; 30, 40, 50);

- measuring the value of the electrical resistance of said sensor device (20; 30, 40, 50) as a function of the values assumed by the pressure (P).

26. Process as claimed in claim 25, characterised in that it associates a pressure threshold (P_{th}) to said threshold thickness (D_{th}).

27. Detection process of a physical quantity as claimed in claim 24 when dependent on at least one of the claims from 14 through 21, characterised in that said physical quantity is a temperature and in that the method comprises the following operations:

- providing a layer with low Curie temperature (122);

- associating said layer with low Curie temperature (122) to a spin valve device (10) in such a configuration that a magnetisation (MF) associated with the ferromagnetic state of said layer with low Curie temperature (122) influences a temporary magnetisation (MT) associated to the free magnetic layer (11) of said spin valve (10);

- forcing an electrical current (I) in said sensor device (120);

- measuring the value of the electrical resistance of said sensor device (120) as a function of the values assumed by the pressure (T).

28. Method as claimed in claim 27, characterised in that if provides a permanent magnetic layer with low saturation (124) able to induce magnetisation (MF) in the layer (122) when said magnetisation (MF) is lost as a result of a transition above the Curie temperature (T_c).

C.R.F., Società Consortile per Azioni
Orbassano TO

"Pressure sensor device, method for its manufacture and method for sensing pressure"

Magnetic pressure sensor device, of the type comprising at least one magnetic layer (11) able to vary a magnetisation associated thereto in response to a pressure (P) exerted thereon. Said device (20; 30; 40; 50) comprises a plurality of layers (11, 12, 13, 14, 15, 16, 17) arranged in a stack, said magnetic layer (11) able to vary a magnetisation associated thereto in response to a pressure (P) comprising a free magnetic layer (11), able to be associated to a temporary magnetisation (MT), said free magnetic layer (11) belonging to said plurality of layers (11, 12, 13, 14, 15, 16, 17), which further comprises at least a spacer layer (13; 23; 33) and a permanent magnetic layer (12) associated to a permanent magnetisation (MP). Said sensor device (20) further comprises a compressible layer (21; 31; 42) and a layer with high magnetic coercivity (22; 32; 42) associated to said plurality of layers (11, 12, 13, 14, 15, 16, 17).
(Figure 2A)